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ABSTRACT

The objectives of this study were to identify and evaluate strategies for organizing prose content that appear appropriate for real-life training applications. An analysis of prose passages in a typical high school science text identified three basic types of graphic representations: associative (AR), comparative (CR), and directed (DR). Once appropriate sets of behavioral objectives were specified and graphic formats displaying each type of relationship were designed, three instructional treatments were prepared: text (T), text-adjunct (TA) in which the text was supplemented with DR and CR diagrams, and text-underlined (TU) in which the graphic information was simply underlined. Groups of 56 Navy recruits, equally divided into high and low science achievement levels, participated in one of the three treatments, followed by free recall and multiple-choice performance tests. The findings were equivocal with respect to the advantages of supplementing prose text with organizational aids; although TA treatment was clearly superior in the free recall of DR materials, TU was superior in terms of multiple-choice test performance on CR materials. Contrary to expectations, no significant interaction between treatment and previous achievement level occurred. (RL)

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Technical Note 79-5

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EFFECTS OF ORGANIZATIONAL AIDS ON LEARNING FROM PROSE TEXTS

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FOREWORD

This research and development was conducted in support of Exploratory Development Task Area ZF55-522-002 (Methodology for Development and Evaluation of Navy Training Programs) and Work Unit ZF55-522-002-01.40 (Alternatives to Formal School Instruction) under the sponsorship of the Director of Naval Education and Training (OP-99).

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DONALD F. PARKER
Commanding Officer

SUMMARY

Problem

The Navy is involved in a major effort to systematize its methods for developing instructional course work. An important consideration for course work development is the organization of instructional content to facilitate learning, but few organizational strategies have been identified that can be applied systematically in real-life instructional settings.

Research has demonstrated that the organization of prose content can improve the learning of complex relationships by bringing related statements into proximity. The restructuring of a passage to bring some related statements together may, however, necessarily separate others of equal relevance. One way to simultaneously emphasize all of the important relationships in a prose presentation is by systematically abstracting and organizing the related points of information into simple graphic displays.

Objective

The objectives of the present study were to identify and evaluate strategies for organizing prose content that appear appropriate for real-life training applications.

Approach

Portions of a typical high school science text were analyzed to identify types of content relationships that might lend themselves to graphic representations. Three basic types of relationships were identified: Associative (AR), Comparative (CR), and Directed (DR). Appropriate sets of generalized behavioral objectives were specified, and simple, easy-to-understand graphic formats were designed for displaying each type of relationship.

Three instructional treatments were prepared: Text (T); Text-Adjunct (T-A), where the text was supplemented by diagrams of CRs and DRs; and Text-Underlined (T-U), where the information contained in the graphic representations was simply underlined in the text. Groups of 56 Navy recruits, equally divided into high and low science achievement levels, each received one of the three treatments, followed by free-recall and multiple-choice performance tests. It was hypothesized that T-A treatments would be superior to both T and T-U treatments, especially for students with previously low levels of science achievement.

Findings

Findings were equivocal with respect to the advantages of supplementing prose text with organizational aids. The only condition where the T-A treatment was clearly superior to both the T and the T-U treatments was the free recall of DRs. The T-A was also superior to the T treatment in terms of multiple-choice test performance on CRs. For this condition, however, the T-A was not superior to the T-U treatment, indicating that the advantage resulted from drawing attention to critical points of information rather than from reorganizing that information. No interactions between student ability and the effects of the treatment were noted.

Conclusions

Findings failed to confirm a strong and consistent advantage for graphic organizational aids used as supplements to typical prose instruction. The effects of the aids may have been weakened by the relatively brief study and retention periods, and because the course content lacked relevance for the students. It was concluded that alternative conditions for presenting and testing the effects of such organizational aids should be investigated.

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INTRODUCTION

Problem

A major effort is being made within the Navy (as well as within other military and civilian organizations) to systematize methods for developing instructional presentations. This effort may be appropriately viewed as an attempt to convert an art into a technology. In the past, it was typically assumed that any literate subject-matter expert could prepare effective course work based on a subjective judgment of what constitutes effective instruction. However, subjective judgment has proven inadequate for the design of effective course work. Rothkopf (1963), in fact, found a strong negative correlation between educators' ratings of instructional materials and the materials' actual effectiveness as determined by student performance.

Efforts to systematize and objectify the process of instructional development have led to the construction of numerous course development documents such as the Navy's Interservice Procedures for Instructional Systems Development (1975) and, in the civilian community, the CORD National Research Training Manual, developed by the Teaching Research Division of the Oregon State System of Higher Education (Crawford, 1969). These documents emphasize behavioral analysis, including the isolation of specific learning objectives that students must master if they are to achieve the goals of the instructional program. At some point, however, the process of analysis must change to one of synthesis. Once the behaviors that students must perform and the information that they need to perform those behaviors have been determined, content should be organized to facilitate understanding and to promote retention. Thus, synthesis is the reorganization of analyzed content into effective instructional presentations.

An important consideration in organizing course work is the type of learning condition involved. Any single method of content organization (such as the Skinnerian "programmed approach") may not be adequate for dealing with the variety of learning conditions that occur in real life. The changing of instructional techniques to match conditions of learning has been advocated by Gagne (1965) in his Conditions of Learning. Gagne suggests that one of the reasons psychology has contributed so little practical knowledge to the field of education is that each theorist has tried to explain all types of learning behaviors based on research performed on a single condition of learning. This position raises serious questions with respect to studies of content organization. Much of this research has dealt with learning tasks that are not representative of classroom instruction; thus, to assess the relevance of such research, it is necessary to determine how the effectiveness of organizational techniques varies with respect to conditions of learning.

Objective

Systematic methods are needed to guide the organization of instructional content into effective presentations. This study's objectives are to review major areas of research involving the organization of prose, to discuss the implications of research findings with respect to interactions between organizational strategies and learning conditions, and to identify and evaluate organizational strategies that appear appropriate for real-life training applications.

Critical Issues in Prose Organization

Levels of Organization

It should be obvious that the organization of prose content can influence instructional effectiveness; for example, a random assignment of words within a paragraph would undoubtedly reduce the content's intelligibility. On the other hand, a change in the ordering of independent chapters in a science text may have little effect. In most studies of prose organization, and in the present study, interest is focused at a level between these two extremes, particularly at the sentence or statement level where facts, rules, and concepts are expressed.

An issue closely related to levels of prose organization is the complexity of the learning. Gagne (1965) describes learning content as being hierarchically related. Rules, for example, represent a higher order of content than concepts since rules are constructed from concepts. Similarly, concepts represent a higher order of content than associations since concepts are formed from related associations. Gagne suggests that simple, lower-order content must be learned before complex, higher-order content. Instruction, he maintains, should be sequenced from the simple to the complex to ensure an appropriate ordering of learning events.

Types of Organization

The categorization of types of organization has been discussed extensively by Lee (1965), who identifies three major strategies for organizing instructional content: unity, sequence, and hierarchy. "Unity" refers to placing topically related ideas together in a passage; "sequence," to the logical ordering of ideas; and "hierarchy," to the degree that some ideas are "more encompassing" than others. It would appear that Gagne's emphasis on learning dependencies, and his model for structuring instruction, are more closely related to what Lee refers to as "sequence" than to "hierarchy."

Purposes of Organization

Merrill and Gibbons (1974) have pointed out that prose may be organized for different purposes or with different points of emphasis. For example, Gagne's hierarchical analysis, which emphasizes relationships among different levels of content, typically results in a structuring of sequences of learning behaviors. In contrast to Gagne, Merrill and Gibbons suggest a heterarchical analysis that indicates content relationships without specifying any particular sequence of learning behavior. A heterarchical approach would, presumably, be appropriate for analyzing relationships at any given level of content as well as between different levels of content and, therefore, would have a broader application than Gagne's model. Since no specific ordering of learning is prescribed, the heterarchical analysis has the further advantage of allowing the learner to select his preferred learning sequence, thus providing some degree of individualization.

Meaningfulness of Relationships

When prose is organized to depict content relationships, a point of consideration is whether the relationships are meaningful or artifactual.

Some organizational strategies are based on characteristics that are irrelevant to an understanding of the content but aid the student's retention of the content. For example, a music teacher helps students to learn the notes that fall in the spaces of the treble cleff by pointing out that they spell out the word FACE. The word is an artifact. It is not a part of what is being learned. Such artifactual relationships are commonly referred to as mnemonics. A review of the use of mnemonics for improving retention has been provided by Senter (1965).

Some organizational strategies focus on relationships that are meaningful with respect to content. Recognizing such relationships may allow the student to deal with the content more efficiently. For example, recognizing the commonality of inversion in fractional division problems allows one to deal with all fractional division problems. Whether a fraction is simple or compound, the divisor should be inverted as a part of the mathematical operations. Knowledge of the commonality of this requirement greatly reduces the amount of information that must be retained to perform such computations. In this case the relationship is not learned as an aid to retention but as a meaningful operation in dividing fractions.

In depicting content relationships to facilitate learning, course writers typically look to meaningful relationships inherent within the content. Artifactual relationships are usually constructed when no adequate, meaningful relationships are available.

Explicitness of Organization

According to Lee (1965), structure is either implicit or explicit. It is implicit when it is not recognized by the student; and when implicit structure is revealed, it becomes explicit. Structural relationships may be made explicit either by directly identifying them or by organizing the content to bring the relationships to the attention of the student. Carter (Note 1) points out that a number of studies (Thompson & Tulving, 1970; Tulving & Osler, 1968; Wood, 1967) have reported that relationships between items are effective retrieval cues only if they are made explicit and stored along with the items that are to be recalled.

Manipulating Prose Organization

Organizing Prose to Structure Behavior

One of the major methods that has been used to facilitate learning is the manipulation of prose organization. In a number of studies, the manipulation's purpose was to structure learning experiences. Most such investigations are based on the premise that learning complex tasks requires the previous acquisition of simpler types of behavior. Gagne's hierarchical model of learning has provided the theoretical background for many of these studies. In terms of establishing an optimum ordering of learning, however, results have been equivocal. While a number of studies (Gagne, 1962; Gagne & Wiegand, 1970; Gagne & Paradise, 1961) have demonstrated that students who fail to learn prerequisite skills fail to learn higher-level tasks. Carter (Note 1) points out that such studies are in reality concerned with what is learned rather than

with the order of learning. That is, they indicate that some tasks cannot be learned unless certain subportions are learned, but they do not indicate that one learning sequence is better than another. Studies that have attempted to demonstrate order dependencies in learning have been less successful. In reviewing eight studies that manipulated the order of learning events, Niedemeyer (1968) found only one (Roe, 1962) showing a significant achievement advantage for a logically sequenced program. The other seven (Krathwohl, Payne, & Gordon, 1967; Levin & Baker, 1965; Miller, Note 2; Niedemeyer, Brown, & Sulzen, 1969; Roe, Case, & Roe, 1962; Stolurow, 1964; and Wodtke, Brown, Sands, & Fredericks, 1967) reported no difference in posttest performance for students receiving logically ordered versus scrambled sequences.

Additional doubts as to the general advisability of structuring learning experiences from the simple to the complex have been raised by Scandura's work in mathematics instruction. Scandura (1973) designed an entire mathematics course by (1) specifying all of the essential rules involved in the instruction, (2) identifying parallels among these rules, and (3) developing higher-order rules that allowed students to generate the lower-order rules. For example, one higher-order rule "showed how rules for converting between numerals in arbitrary number bases (e.g., 2, 5) can be derived from a single rule for converting, say, between base 10 and base 8 numerals" (1973, p. 10).

Ehrenpreis and Scandura (1972) found that learners who were taught only a reduced set of higher-order rules performed as effectively as learners who were taught the complete set of lower-order rules. These findings do not negate Gagne's position that some tasks can be reduced to sets of subtasks that must each be mastered if the overall task is to be performed effectively. However, such findings do demonstrate that the performance of complex higher-order skills is not always dependent upon the prior mastery of related skills at a lower conceptual level.

Organizing Prose to Clarify Relationships

Dansereau, Evans, Wright, Long, and Actkinson (1974) describe a wide variety of strategies that have been employed in organizing prose content. Some of these strategies appear to be more concerned with the clarification of content relationships than with the structuring and control of learning behaviors. The distinction between content- and behavior-oriented instructional approaches has been emphasized by Merrill and Gibbons (1974) who contrast a hierarchical analysis, which specifies or implies an ordering of learning objectives, with a heterarchical analysis, which gives the student "a representation of the subject matter which facilitates his own storage and retrieval of the content in memory" (p. 146). In Lee's (1965) terminology, the purpose of a heterarchical approach to prose organization is to make implicit content explicit. However, attempts to clarify relationships by manipulating content organization have yielded mixed results, depending upon the characteristics of the content.

Word Lists. Efforts to demonstrate practical advantages from organizing prose to bring content relationships to the attention of the students derive from studies of clustering effects in the retention of word lists. Bower, Clark, Winzenz, and Lesgold (1969) presented groups of words to students for memorization. The words could be structured into conceptual hierarchies.

Recall was superior when word presentations were organized according to these conceptual hierarchies rather than to random assignments. The students also tended to recall the material in a hierarchical order, proceeding from inclusive concepts to lower-level instances of the concepts. It was hypothesized that recognition of the relationships provided cues for recalling the more specific instances.

Tulving and Pearlstone (1966) provided further evidence of the effects of organization on word list retrieval. Word lists of 12, 24, or 48 words organized into categories of 1, 2, or 4 words were presented. At recall, only half of the subjects were given the category names. Following the initial recall, all subjects were given the category names. Results indicated that providing category names at the time of recall facilitates the retrieval of individual words. These results are consistent with the hypothesis that the knowledge of relationships among words facilitates their retention, and further, demonstrate the importance of making such relationships available at the time of retrieval.

Independent Prose Statements. On the basis of such word-retention studies, Carter (Note 1) attempted to demonstrate similar facilitative effects for hierarchical relationships in prose. For this purpose, Carter created prose passages describing a fictitious Indian tribe named the "Himoots." The passages consisted of relatively independent statements that could be grouped according to hierarchically related topic areas.

In contrast to the word-list retention studies (Bowser et al., 1969; Tulving & Pearlstone, 1966) Carter found no advantage for a hierarchically ordered presentation. Learning sets also failed to produce significant differences in test performance. In a follow-up study by Carter and Carrier (1974), evidence of an advantage for organized over random presentation was established, but only when topic headings were identified for the subject, and only when three exposures of the passages were given.

Complex Prose Relationships. The findings of Carter and Carrier certainly do not indicate a robust effect for organization, and appear particularly discouraging in terms of practical applications. These authors compared random orderings of statements against the strongest, most beneficial orderings that they could devise. In practice, most prose presentations are already organized to some degree; course writers typically present concepts in a logical fashion and group similar topical content together. For an organizational strategy to be practical, it must produce results that compare favorably with the prevailing methods of prose presentation.

Perhaps the weakness of Carter and Carrier's results can be attributed to content simplicity. As they themselves suggest, "before the effects of organizational characteristics of prose can be adequately studied, the experimental paradigm will have to involve materials of greater complexity and longer duration" (1974, p. 48). Some evidence of stronger organizational effects for prose with more complicated types of content relationships has, in fact, been established. Kissler and Lloyd (1974), for example, found that scrambling affected the learning of interrelated prose sentences but not independent ones.

Further evidence of the effects of prose organization on the learning of complex content relationships has been provided by a series of studies following another line of research (Frase, 1969, 1973; Schultz & DiVesta, 1972; Friedman & Greitzer, 1972; Myers, Pezdeck, & Coulson, 1973). In these studies content consisted of a number of subject names, each of which was assigned specific characteristics with respect to a number of attributes (e.g., a group of fictitious countries that differ with respect to industrial and geographical attributes, or a group of fictitious fish that differ with respect to general physical attributes). Results of these investigations demonstrate that organizing passages according to some structural characteristic of the content does facilitate recall. All four of those experiments that compared presentation organized by name or attribute against a random organization found organization by attribute to be superior to random presentation. Three of the experiments (Frase, 1969; Myers et al., 1973; and Schultz & DiVesta, 1972) also found organization by name superior to random presentation.

The advantage of the organized presentations may have been related to the way the subjects organized their recall. Two studies (Schultz & DiVesta, 1972; Friedman & Greitzer, 1972) found the clustering of responses at recall to be congruent with the order of presentation.

Frase (1969) also reported advantages from providing advance information concerning the superordinate structure of his presentation, but these findings do not support Ausubel's (1960) arguments for advanced organizers. Frase's effects were obtained only for the second and third presentations of his content. At these points, information on the superordinate structure had been preceded by presentations of specific content. Effects of advanced organizers can be determined only under conditions where the superordinate structure precedes the content.

As noted previously, there is little practical value in demonstrating that an organized prose presentation is more effective than an unorganized one. A more critical matter is whether some methods of organization are better than others. Two studies (Friedman & Greitzer, 1972; Myers et al., 1973) did report higher levels of free recall for attribute-organized than for name-organized passages, but Friedman and Greitzer attributed their results to hierarchical relationships among the attributes and warned against generalizing these findings to other types of content. Furthermore, the advantages for attribute-organized passages, as reported by Myers et al., varied from one experiment to another and were dependent upon constant maintenance of the serial position of information--a requirement not usually satisfied by typical prose instruction.

Frase (1973) initially found that, when variations occurred in the semantic structure of sentences, organization by name was superior to organization by attribute. In further experiments where the same values appeared under both name and attribute, variations in serial position were more disruptive for name-organized presentations. Clearly, for free recall, neither method of organization appeared to have a strong and consistent advantage over the other.

Free recall may not be a good criterion for instructional effectiveness. Typically, the student is expected to do something more than recall isolated

facts. He is also expected to relate these facts to each other and, perhaps, to apply them in some sort of task. With respect to the integration and application of information, the advantages of organization are less well documented. Frase (1969) found no advantage for organized versus unorganized passages in teaching subjects to recognize appropriate chess moves. In a later study, however, Frase (1973) was able to establish that organization can assist the subject to answer questions that require the integration of information. The more effective organizational strategy, in this case, is the one that brings the information into proximity within the presentation.

In cases where it is important to structure prose instruction to bring related information into proximity, it is relevant to consider methods for identifying and assigning priorities to content relationships. Dansereau et al., (1974) describes two approaches that have been considered for this purpose. One involves methods for describing the semantic structure of text passages by "separating the structure into underlying components representing semantic content and superficial components corresponding to style" (p. 55). The other involves multidimensional scaling, a method for "obtaining judgments about the extent to which pairs of items are related" (p. 56).

While such approaches appear useful, they should not be expected to eliminate problems associated with the structuring of instructional prose content. Whatever method is used to identify important content relationships, the course writer is left with the dilemma of how to bring some related facts together without separating others. Furthermore, if superficial prose components are minimized to clarify relationships between meaningful content there is risk of producing a prose style that is tedious and dull.

Depicting Content Relationships

All of the studies cited so far have attempted to clarify content relationships by manipulating the organization of prose presentations. Another method is to depict the critical relationships separately from the prose passages. In general, methods for depicting content relationships may be separated into two categories: those that depict only the superordinate structure of the content, and those that depict specific content relationships.

Superordinate Structure

Superordinate structure refers to content relationships at a higher order of abstraction and generalization than those to be learned by the subject. It has been clearly established that a knowledge of superordinate structure can facilitate prose learning. Although Gagne and Wiegand (1970) demonstrated that recall of prose content improved when such higher-order information was provided at the time of recall, providing superordinate structure at or before the time that instruction is presented has resulted in negative or inconclusive results. An early study by Robinson and Hall (1941) found no instructional advantage for the addition of paragraph headings. A later study by Christensen and Stordahl (1955) found a similar lack of effects for statement or question headings, pre- or post-summaries, outlines, or underlinings.

A study by Lee (1965) claimed facilitating effects from the addition of paragraph structure (introductions, summations, underlined headings, and transitional paragraphs). However, Carter (1972) points out that Lee's facilitative effects only occurred with essay questions on main ideas. Performance was not enhanced for recall or recognition of more detailed information within the passage. In Lee's study, then, the superordinate structure did not facilitate the learning of subordinate information, but rather the learning of information related to the superordinate structure itself.

Gagne (1969) claimed facilitating effects from providing superordinate information at the same time that the subordinate information is presented. He presented fourth grade students with science facts embedded in four related coordinate sentences or in three coordinate sentences with one superordinate topic sentence. Subjects recalled the facts better when a superordinate sentence was included. However, Gagne's results could be interpreted in terms of retention requirements rather than superordinate facilitation. The superordinate sentence may have been viewed by subjects as information that did not have to be retained. This would require them to remember only three rather than four sentences.

Another series of studies investigated the depiction of superordinate structure before the instructional experience. These studies were based on Ausubel's position that advance organizers (information "at a much higher level of abstraction, generality and inclusivensss" than the information to be learned) facilitate learning by allowing the subject to incorporate new material into existing cognitive structures (1960, p. 271). Ausubel's findings indicate that subjects who received such advance organizers performed significantly better on a test of the content of a learning passage than subjects who did not, even though the test performance of subjects receiving the advance organizers alone was only slightly better than chance. Carter (Note 1, p. 26) points out that replications of Ausubel's study either found confounding facilitative effects from the advance organizers (Ausubel & Fitzgerald, 1961) or neglected to determine whether the advance organizer had a direct instructive effect, "which confounds any interpretation of the effects of the advance organizer on learning from the instructional passage itself." This latter group of studies includes investigations by Allen (1970), Ausubel and Fitzgerald (1962), Ausubel and Youssef (1963), and Schultz (Note 2).

Specific Relationships

A second category of studies has not been limited to the superordinate structure of the instructional presentations but has depicted relationships among the specific factual elements to be learned. Evidence of facilitative effects from such depictions was provided by Scandura and Wells (1967) with respect to mathematics materials. They referred to their depictions as advance organizers. However, Carter (Note 1) points out that, in terms of Ausubel's (1960) theoretical position, advance organizers should provide structure at a more general level than that of the material to follow. Therefore, Scandura and Wells support the depiction of the specific relationships to be learned rather than superordinate structure in the form of advance organizers.

Mathematical relationships obviously lend themselves to symbolic depictions. However, any type of relationship can be abstracted from a prose content and depicted graphically. Since graphic representations can present all

critical elements in proximity, they should facilitate, according to Frase (1973), the learning of such elements. Representations such as tables, matrices, or algorithms are, of course, in common use as instructional materials. In the past, however, few efforts were made to evaluate the effectiveness of such devices, to determine the limits of their advantages, or to devise systematic approaches for their application. (It is interesting to note that studies comparing name-organized and attribute-organized presentations all used matrix diagrams in reporting their investigations but did not evaluate the diagrams as methods of instructional presentation.)

A few recent research efforts support the value of graphic representations that summarize content relationships. Gropper (1970) found that several types of verbal diagrams (i.e., labels, short phrases, block diagrams, and arrowed lines) all produced better learning of verbal chains than an undefined "conventional instruction." Holliday (1976) found that both a pictorial presentation and a word-diagram presentation resulted in better learning of a series of cause-and-effect relationships than did textual descriptions. In these graphic representations, Holliday replaced connecting words and phrases in the textual descriptions with line drawings or block figures and design elements, "thereby increasing the theoretical chances of mental linkage formation among verbal labels" (1976, p. 73). Holliday's approach brings together informational elements that the student would need to integrate in order to satisfy test performance requirements. In this respect, his methods are supported by Frase's (1973) study.

Unfortunately, Holliday provides no information concerning study times. The possibility that subjects received longer study sessions with the word-diagram and pictorial presentations than with the textual prose cannot be discounted.

Comparisons of prose instruction and graphic presentations have not always favored the latter. Wright and Reid (1973) compared a flowchart algorithm, a two-dimensional table matrix, and a series of short sentences against a "bureaucratic" prose style. The content concerned various fictitious methods of future travel. The task was to select the best method (e.g., fastest, cheapest) for a particular set of requirements. Findings indicated that retention over time was superior with the short sentences.

It is not unreasonable to expect prose presentations to be instructionally superior to graphic representations in some situations. Prose, either spoken or written, is our most common form of communication. Furthermore, some ideas are difficult to symbolize graphically. New concepts often have to be explained in detail, perhaps with examples or with analogies to previous experiences. A reasonable practice might be to combine presentation formats. The prose passage could be used to introduce concepts and explain relationships in a typical textbook fashion, and the graphic representations could provide a summation and clarification of these relationships by eliminating nonessential elements and grouping essential elements.

Although the use of graphic representations to clarify relationships contained in prose passages is not a new concept, the potential utility of

such procedures is still a matter of conjecture. We are, in fact, only beginning to systematically investigate the benefits of combining text with graphics. To date the findings have not been encouraging. In a review of recent writings on the instructional applications of diagrams, Holliday (1976) states: "Surprisingly, recent diagram and attention theory and research suggest that a single flow diagram alone with instructive questions constitutes the most effective presentation" (p. 64).

Holliday's conclusion is largely based on studies of attentional behaviors (Fleming, 1962; Anderson, 1970; Samuels, 1970) suggesting (1) that, given a choice of two instructional formats, learners tend to select the one requiring the least effort, and (2) that most learners generally favor the textual portion of books over adjacent pictorial displays. Holliday's position is supported by his own findings (1976) that combinations of diagrams and text were less effective than diagrams alone, and no more effective than text alone.

Still, Holliday's findings leave two major questions unanswered. First, if the materials were presented in such a manner that the students were forced to study both types of presentations, would a dual mode of presentation then be facilitative or would it set up incompatible learning strategies and reduce instructional effectiveness? Second, would a simpler type of graphics than those used by Holliday be more beneficial for use in conjunction with text? This second question is important because Holliday claims that students prefer prose to diagrams because of the latter's relative complexity. An examination of Holliday's diagrams makes the students' preference understandable--the diagrams were extremely complex, making the extraction of information difficult. Since one of the main purposes of providing graphic representations is to simplify complex relationships, a simpler type of graphic should probably be used in conjunction with text.

A final point of interest regarding the effects of organization is student learning capacity. Although studies provide little evidence of interactions between learner characteristics and content organization, such interactions should be expected. Carter (Note 1) argues that one of the reasons that manipulations of text organization have failed to affect performance is that the learner has a robust ability to reorganize content mentally. Since poor learners are probably less proficient at organizational skills than good learners, they should benefit more from organizational aids.

METHOD

The present study was conducted to determine whether or not organizational adjuncts in the form of graphic representations of conceptual relationships enhance the effectiveness of instructional prose. Although the intention was to implement and evaluate such adjuncts under real-life instructional conditions, it proved impossible to obtain enough subjects to train and test over time with meaningful job-related content. In practice, therefore, realistic conditions could only be approximated using abbreviated training and testing periods and course work that was likely to be unrelated to the subjects' job assignments. These necessary deviations from the ideal condition must be considered in drawing conclusions from the experiment.

Design

The experimental design called for comparisons of three instructional treatments and for two levels of achievement on a general science test. The three treatments were (1) Text (T), conventional textual prose passages; (2) Text-Adjunct (T-A), the same passages supplemented by adjunctive organizational aids (i.e., graphic representations of related statements); and (3) Text-Underlined (T-U), the same passages supplemented by underlined passages setting off those statements that constituted the graphic representations for the T-A treatment.

The T-U treatment was provided to determine whether or not any facilitative effects could be attributed to selective attention. If the effect of organizational aids is simply to direct the student's attention to critical portions of the instruction, then a similar facilitative effect might be expected from identifying critical information without modifying the structure of the instruction.

Identifying high and low achievement groups in terms of general science knowledge served a dual purpose. First, it allowed a statistical accounting for part of the within-subject variance. Second, it provided a means for identifying possible interactions between organization and study skills. It is possible that students with higher levels of general science knowledge have acquired more effective strategies for retaining the complex content relationships that one often encounters in explanations of scientific phenomena. If such is the case, then clarifications of content relationships would be more beneficial to low achievers who have not developed as effective a set of study behaviors.

Subjects

The subjects were 224 Navy enlisted personnel from four recruit training companies. These personnel represent a broad range of academic abilities and technical backgrounds. Participation was voluntary, but none of the personnel who were solicited refused to take part in the study.

Materials

Text

The basic instructional content was adapted from a high school general science text (Davis, Burnett, & Gross, 1961) used by the United States Armed Forces Institute as a part of its General Educational Development series. The passages selected, all concerning the formation of weather conditions, covered four different topics: movement and characteristics of air masses, development of storms, evaporation and condensation, and measurement of relative humidity. Some changes in the wording of the original text were made so that statements could be lifted out of context and organized into a diagram with only minor grammatical variations.

Content of Organizational Aids

The organizational aids were developed as follows: First, the passages were examined to determine the types of relationships that would be relevant to an understanding of weather phenomena. Three distinctive types of relationships were identified:

1. Associative Relationships (ARs), which establish connections between a subject (e.g. person, object) and two or more attributes (e.g., a hygrometer, which measures relative humidity, consists of two types of thermometers, and responds to change in temperature and moisture).

2. Comparative Relationships (CRs), which provide comparisons of two or more subjects with respect to one or more attributes (e.g., tornadoes form on land; waterspouts, at sea).

3. Directed Relationships (DRs), which relate cause and effect (e.g., an increase in relative humidity reduces evaporation, which lessens the cooling effect of evaporation on a wet-bulb thermometer and raises its temperature).

After the major types of relationships in the text passages were determined, the content of the passages was reviewed to locate all examples of each relationship. The review was conducted separately by the author and two research assistants. Relationships were designated as AR, CR, or DR only when there was unanimous agreement among the reviewers.

A general type of instructional objective was specified for each of the three types of relationships. For ARs, the objective was to be able to choose correct attribute values for a given subject (e.g., Do hygrometers measure humidity or relative humidity? Do they consist of one or two types of thermometers?). For CRs, the objective was to choose correctly the attribute associated with a subject or set of subjects (e.g., Which types of storms are caused by a rapid increase and which by a decrease in temperature? Which storms form on land and which form at sea?). For DRs, the objective was to indicate correctly the effect of a causal factor in a chain of events (e.g., Will an increase in evaporation raise or lower the temperature of a wet-bulb thermometer?).

Format of Organizational Aids

Organizational aids were developed to serve as adjuncts to the printed test materials. The development, while guided by relevant research findings, was largely a process of trial and error based on the opinions of the investigators and on the reactions of Navy enlisted personnel who participated in pilot evaluations. Since one of the major reasons cited for previous failures of organizational adjuncts was the relative complexity of the graphics (Holliday, 1976), every effort was made to keep the adjuncts as simple and straightforward as possible.

Each relationship in the adjunct was introduced by a title indicating the general subject area (e.g., Movements of Air Masses) and a topical question indicating the characteristics of the information the student should abstract from the adjunct (e.g., What are the characteristics of fronts and how do they form?). These introductory questions were not present in the original text. However, to prevent the effects of the questions from being confounded with the effects of organization, the same questions were also introduced at appropriate points in the text.

The formats of the organizational aids were varied to correspond to the types of relationship being depicted. For ARs, the subject was identified and a numbered listing of its relevant attribute values was constructed. For example:

In the region of the stratosphere:

1. Air temperature is very cold.
2. The oxygen level is too low to support life.
3. The air temperature is too low to support life.
4. There are no clouds.

For CRs, a matrix arrangement was used to provide a comprehensive comparison of all subjects and attributes in a single presentation. A partial replication of a CR adjunct is presented in Figure 1.

	Warm Front	Cold Front
Formed when	Warm mass pushes into colder	Cold mass overtakes warm mass
Air Pressure	Low	Low
Storm Develops	Slowly	Swiftly
Moves	Slowly	Rapidly

Figure 1. Partial replication of a Comparative Relationships adjunct.

Finally, for DRs a flowchart was used to depict the order of events in cause-and-effect relationships. Where multiple causes or effects were involved, a branching system was utilized. A partial replication of a DR adjunct is presented in Figure 2.

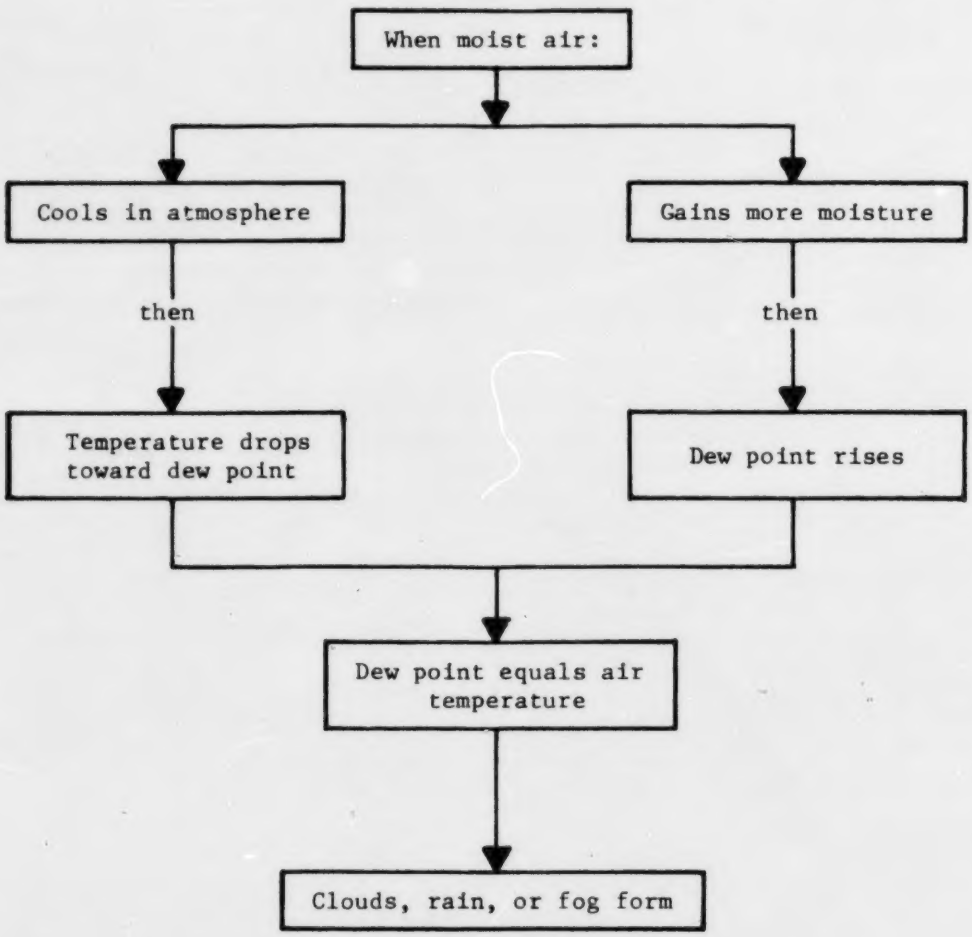

Figure 2. Partial replication of a Directed Relationships adjunct.

Underlined Texts

The underlined versions of the text were constructed by simply underlining all of the text phrases that appeared in the adjuncts. A portion of the underlined text covering the statements contained in Figure 1 is as follows:

> . . . A warm front is formed when a mass of warm air pushes into a colder air mass. A cold front is formed when a mass of cold air overtakes a mass of warm air. There is usually an area of low air pressure at a warm or cold front because of the rising currents of air. The terms warm and cold as used here refer to the relative temperatures of the air masses. Thus, a cold air mass in summer may be many degrees warmer than a warm air mass in winter. The movement of the air currents at a front depends on the difference in temperature of the air masses involved.
>
> The weather that accompanies warm and cold fronts is as follows: Warm fronts usually move slowly, at speeds of from 20 to 30 miles per hour. Storms at warm fronts develop slowly. The first indication of an approaching warm front is the appearance of high thin clouds. As the front nears, the clouds get lower and darker. Finally, the sky is black, and it rains or snows. This whole process may take two or three days. By contrast, cold fronts move much more rapidly . . .

Content Coverage

Pilot testing indicated that the entire weather content could not be adequately covered within the time period available. Therefore, coverage was reduced to four sections of the chapter and to only CR and DR relationships. ARs were considered the least complex relationship (an AR could be considered a CR with only one subject) and, therefore, less likely to need diagrammatic simplification. For this reason, no evaluation of organizational aids based on ARs was attempted in the present study.

Relationships were depicted in the four selected topic sections as follows: One section, titled "Evaporation and Condensation," was covered by a 2 x 1 CR matrix and a 10-box DR flow diagram; a second section, titled "Measuring Humidity," by a 6-box DR flow diagram; a third section, titled "Movements of Air Masses," by a 2 x 5 CR matrix; and a fourth, titled "Weather Disturbances," by a 4 x 5 CR matrix.

Tests

The subjects' science achievement levels were determined by preinduction scores on the General Science (GS) subtest of the Armed Services Vocational Aptitude Battery. This subtest, which includes 20 multiple-choice items on the physical and biological sciences, is administered to all enlisted military recruits and is used in conjunction with other subtest scores to screen personnel for electronics ratings. GS scores have been validated against final

performance scores in Navy Class "A" Schools. For schools with content relating to the physical or biological sciences (e.g., Hospitalman, Electronics Technician, Fire Control Technician, Communications Technician), correlations between GS scores and final school performance (corrected for restrictions in range) were consistently significant, varying from .42 to .67 and averaging about .55.

Two types of tests were used to compare the instructional effectiveness of the experimental treatments: a free-recall test and a 44-item, multiple-choice test with two choices per item. Two-choice items were particularly appropriate with respect to DRs, since the causal relationships being studied typically involved a possibility of two results (e.g., higher/lower, increase/decrease). The two-choice format was adaptable to all of the relationships dealt with in this study and was used throughout the multiple-choice test to provide a consistent format.

Carter (Note 1) argues that free-recall tests should be more sensitive to organization effects since they provide no cues as to hierarchical relationships. However, the multiple-choice test was deemed to be the more important of the two tests used in the present study. The instructional objectives that were specified for this study require subjects to integrate related information that may be located in various portions of the text. While a free-recall test creates no requirements for the integration of information, multiple-choice questions can be designed to create such requirements.

Of the 44 multiple-choice items, 11 were CR items and 15 were DR items. The remaining 18 items dealt with factual information that was included in the prose passages but was not relevant to any of the relationships depicted in the organizational adjuncts. These were designated as nonrelevant (NR) items. The CR test items required the subject either to associate a subject with its appropriate attribute value (Example 1) or to associate the correct subjects with a common value (Example 2).

Example 1. A tornado forms when air pressure _____ rapidly.

a. rises
b. drops

Example 2. Hurricanes and _____ usually originate in the same general areas.

a. tornadoes
b. waterspouts

The DR test items required the subject to identify either the result of a specified causal event or the cause of a specified result (Example 3).

Example 3. A large difference between wet- and dry-bulb readings may be taken as an indication of _____ relative humidity.

a. high
b. low

Note that DR items may require the subject to recognize relationships between events that are not immediately related. The above item, for example, concerns a series of events in which relative humidity affects the rate of evaporation, which, in turn, affects the temperature of a wet-bulb thermometer and, consequently, its reading relative to a dry-bulb thermometer. If the subject has satisfied the instructional objective and formed an understanding of the process by which events in the DR occur, then he should be able to reconstruct the process and form a correct association between any two steps in the series.

The NR items required the subject to recognize the missing portion of a verbatim or paraphrased replication of a statement presented in the text (Example 4), but not in the organizational adjuncts.

Example 4. Hurricanes occur in _____ summer.

a. early
b. late

Note that NR items are distinguishable from CR and DR items only in terms of the instructional objectives; that is, for NR items subjects were not required to recognize relationships between attributes or ordered events. The NR items were used to determine whether advantages obtained with respect to the retention of conceptually related facts would be obtained at the expense of the more independent statements. Rothkopf and Bisbicos (1967) reported such shifts in performance from one type of information to another as a result of inserting different types of questions into text.

All multiple-choice items were individually reviewed for clarity and adequacy of content coverage by two research psychologists and four graduate assistants. Any items that were difficult to understand or to relate to the text were either deleted or revised. Although some topic areas were found to provide more test items than others, there was general agreement that the test items provided an adequate coverage of the four topic sections.

The free-recall test was developed to determine whether or not differences in the ability to identify correct statements of relationships would correspond to differences in the ability to recall factual information concerning those relationships. As Frase (1969) demonstrated with respect to an understanding of chess moves, significant improvements in free recall do not necessarily result in improved capabilities to apply that information. On the other hand, it would be expected that improvements in the ability to answer questions about a given subject could result from improvements in the recall of information relevant to that subject. The free-recall test was included in the present study to assess this latter possibility.

Only one CR and one DR were covered by the free-recall test. This restriction was necessary because of the limited time available for testing. Free-recall test sheets consisted of blank pieces of paper, each with the same topic question that appeared on the corresponding organizational adjunct and text section. For the CR free-recall test sheet, the question was: What similarities and differences are there in the formation of tornadoes, waterspouts, hurricanes, and thunderstorms? For the DR recall test sheet, the question was: What is the process by which warm, moist air is condensed into clouds, fog, rain, and dew?

Form B of the Vocabulary portion of the Nelson-Denny Reading Test was administered between the end of the study period and the beginning of testing. This was done to interrupt attempts to maintain information in short-term memory by rehearsal.

Finally, a brief questionnaire (see Appendix) was developed that directed subjects to indicate how adequately they were able (1) to cover the content within the available study times and (2) to understand and utilize the organizational adjuncts.

Procedure

Assignment to Treatments

The subjects were from four companies of 53 to 84 recruits. All subjects were designated as "Highs" (General Science scores above 55) or "Lows" (General Science scores at or below 55). Previous testing had indicated that this categorization would result in approximately equal numbers of Highs and Lows. To ensure that their learning skills would be adequate to deal with the training content, those (about 5%) with scores below 40 were eliminated from the experiment.

Treatments were assigned separately for Highs and Lows. Assignments were sequenced by company number and, within companies, by alphabetical order until 28 subjects had been designated for each experimental cell. The subjects in the first three companies were assigned at random to instructional treatments, and the fourth company received no instruction. All four companies were administered the multiple-choice test in the same manner.

Administration of Treatments

All subjects were informed that the purpose of the study was to evaluate methods for presenting instruction and that findings from this effort would be applied to make Navy course work easier and more interesting. Previous investigations had revealed that Navy enlisted personnel respond favorably toward participation in efforts to improve Navy course work. In accordance with Navy testing regulations, subjects were also informed that their participation would be voluntary.

The subjects who received instruction were given 16 minutes to study the four prose passages. It was suggested that they spend 4 minutes studying each passage, and they were cued as each 4-minute time period elapsed. Following the study period, subjects were provided an 8-minute review period. For Treatment T, subjects were instructed to review the passages that they had already studied; for Treatment T-U, copies of the text with related statements underlined; and for treatment T-A, sets of diagrams that summarized statement relationships. It was suggested that they spend 2 minutes with each topic, and they were cued as each 2-minute time period elapsed. Following the 8-minute review, subjects were given a final 5 minutes to study and review any of the materials that they had received.

Following the instructional periods, subjects were administered the vocabulary test for 10 minutes. Then they were administered the multiple-choice test for 25 minutes, followed by the free-recall test for 16 minutes and, finally, by the opinion questionnaire.

Scoring of Tests and Questionnaires

Scores for the multiple-choice test were represented by the number of test items answered correctly. Scores were tabulated for the entire test and for separate portions of the test covering CR, DR, and NR items.

In scoring free-recall performance for the CR questions, one point was given for each correct association made between a subject and an attribute value. In addition, points were given for each subject that was correctly related to another subject with respect to any given attribute (e.g., waterspouts and tornadoes are both caused by a sudden change in temperature). In the above statement two subjects are being related with respect to a single attribute, so two points would be scored. Two specific statements, each correctly associating a given subject with the same attribute, would receive a score of four points, one for each specific association and two for the relationship implied between the two subjects. The highest possible score for the CR portion of the free-recall test was 16 points.

For the DR portion of the free-recall test, scores were based on the number of correct cause-and-effect relationships that could be generated from the recalled content. For example, if the subject recalled that event a causes b and event b causes c, then three such relationships are implied (ab, ac, and bc), so a score of three points would be given. Recalled relationships were given credit even if some intermediate steps were missed. Suppose, for example, the relationship was: "Event a causes b, b causes c, c causes d, and d causes e." If the subject forgot b and only remembered that a causes c, c causes d, and d causes e, he would still receive 6 points for the six possible relationships implied by his recall (ac, ad, ae, cd, ce, and de). The highest possible score for the DR portion of the free-recall test was 20 points.

Questionnnaire responses with respect to the adjunctive diagrams were given numerical values. For usefulness, a response of "Very Useful" was assigned a value of 3; "Useful," a value of 2; and "Not Useful," a value of 1. Similarly, for understanding, a response of "Very Easy" was assigned a value of 3; "Easy," a value of 2; and "Difficult," a value of 1. Questionnaire responses with respect to topic coverage were scored in terms of the number of topics covered.

RESULTS

To maintain groups of equal size, only 28 of the subjects assigned to each group were included in the data analysis. This provided eight groups of 28 subjects, four groups with relatively low and four with relatively high levels of general science achievement. Mean General Science (GS) scores for the eight groups are presented in Table 1. A summary for a 2 x 4 analysis of variance (ANOVA) performed on these GS scores is presented in Table 2. This analysis reveals the expected significant differences between high and low GS groupings but no significant main effects or interactions involving treatment assignments.

Table 1

Mean GS Scores for All Subject Groupings

Achievement Groups	N	Test Only	Instructional Treatments		
			T	T-U	T-A
High	28	60.8	61.7	61.9	62.0
Low	28	47.4	48.9	48.9	50.3

Table 2

ANOVA Summary for GS Scores of Test and Treatment Groups

Source	df	ms	f
Treatments (A)	3	26.0	.7
GS Levels (B)	1	9218.6	244.7*
A x B	3	58.5	1.5
Residual	216	37.7	

*p < .001.

Multiple-choice Test Performance

Test Validity

The validity of this test was determined by comparing test scores against a previously established measure of achievement on science-related content; namely, the GS scores. A Pearson Product-Moment Correlation for 168 subjects who received the instructional treatments indicated a statistically significant positive relationship ($r = .49$, $p < .001$).

Instructional Effectiveness of Text

The major hypothesis of the present study was that the effectiveness of typical textual instruction can be enhanced by organizational aids. This hypothesis assumes that the course work is already reasonably effective. To assess the effectiveness of the course work, overall scores were compared for groups receiving treatment T and groups receiving no instruction. Mean multiple-choice test performance scores for these two groups (along with those of the rest of the groups) are displayed in Table 3. A summary for a 2 x 2 ANOVA performed on these scores is presented in Table 4.

Table 3

Mean Number of Correct Items on the Multiple-choice Test

Item Types	GS Level	Conditions of Instruction			
		None[a]	T	T-U	T-A
All	High	25.6	31.8	33.8	33.5
	Low	24.5	27.4	26.7	28.6
CR	High	--	8.8	9.9	9.6
	Low	--	7.0	7.6	8.0
DR	High	--	9.5	9.5	9.9
	Low	--	8.2	8.2	8.8
NR	High	--	13.6	14.4	14.1
	Low	--	12.2	11.0	11.8

Note. Each mean is based on the scores of 28 subjects.

[a]Only overall scores covering all types of items are used in comparing groups receiving no instruction against treatment groups.

Table 4

ANOVA Summary for Overall Multiple-choice Test
Scores for Groups Who Did and Did Not Receive Instructional Texts

Source	df	ms	f
Treatments (A)	1	695.0	36.5*
GS Levels (B)	1	237.2	12.5*
A x B	1	55.7	2.9
Residual	108	19.0	

*$p < .001$

The results indicated statistically significant main effects both for treatments and for GS levels. Subjects who received the instructional text scored significantly higher on the multiple-choice test than those who did not, and those with high GS achievement scored higher than those with low GS achievement. The interaction between treatments and GS levels was not significant.

Comparison of Treatments

Separate 2 x 3 ANOVAs were conducted for overall test performance and for performance on each type of multiple-choice test item. Each of these analyses compared groups of subjects with high and low GS scores that received instructional condition T, T-U, or T-A. Mean multiple-choice test scores for each group are presented in Table 3. A summary for the four analyses is presented in Table 5. Results of the analysis of overall performance scores indicated a large significant main effect for GS levels but no effect for treatments and no interactions.

A significant main effect for GS levels was found for CR, DR, and NR items. Main effects for instructional treatments were only found for CR items and there were no significant interactions. However, an inspection of Table 3 reveals that means were consistently higher for the T-A than for the T treatment except for NR items, which did not test for knowledge of content relationships.

From an examination of mean CR scores in Table 3, it appears that treatment effects could be attributed to differences between T-A and T. This possibility was verified by applying a Dunnett post-hoc test. In applying the Dunnett test the typical procedure of comparing several treatments against a control was reversed since, in this case, two controls (the T and the T-U treatments) were being compared against a potentially superior condition (the T-A treatment). Application of the Dunnett test revealed that mean CR performance scores for the T-A treatment were significantly higher than those for the T treatment ($d = 2.31$, $p < .05$) but not higher than those for the T-U treatment.

Table 5

ANOVA Summary for Multiple-choice Test Scores
for Treatment Groups Receiving Instruction

Item Types	Source	df	ms	f
All	Treatments (A)	2	33.0	1.4
	GS Levels (B)	1	1237.7	53.4**
	A x B	2	29.5	1.3
	Residual	162	23.2	
CR	Treatments (A)	2	18.4	4.0*
	GS Levels (B)	1	139.3	30.1**
	A x B	2	2.3	.5
	Residual	162	4.6	
DR	Treatments (A)	2	3.6	.7
	GS Levels (B)	1	56.0	11.5**
	A x B	2	.4	1.0
	Residual	162	4.9	
NR	Treatments (A)	2	1.1	.2
	GS Levels (B)	1	233.4	41.7**
	A x B	2	14.6	2.6
	Residual	162	5.6	

*$p < .05$
**$p < .001$

Free-recall Test Performance

Because of the limited time available for testing, only two of the four topic areas covered by the multiple-choice test were tested for free recall. One of these topics contained a DR; and the other, a CR.

Interrater Reliabilities

Before the final grading of recall responses, a sample of 30 recall sheets (5 selected from each of the 6 treatment groups through random numbers) was graded separately by 3 individuals to determine interrater reliabilities. For the CR topic the average interrater reliability was .90; for the DR topic, .83. This level was sufficient to allow for separate grading of the remaining responses. Graders blind-scored each recall sheet without information concerning GS or group membership.

Comparison of Treatments

Separate analyses were performed for overall free-recall scores and for CR and DR portions of the free-recall test. Mean free-recall scores for each treatment group are displayed in Table 6, and a summary for the three analyses is presented in Table 7.

Table 6

Mean Free-recall Scores

Test Portions	GS Level	Conditions of Instruction		
		T	T-U	T-A
CR and DR	High	13.3	16.3	18.0
	Low	8.0	7.2	9.4
CR	High	9.3	11.6	11.0
	Low	5.9	5.4	6.7
DR	High	4.0	4.7	7.0
	Low	2.1	1.8	2.7

Note. Each mean is based on the scores of 28 subjects.

Table 7

ANOVA Summary for Free-recall Scores for Treatment Groups

Test Portions	Source	df	ms	f
CR and DR	Treatments (A)	2	117.6	2.2
	GS Levels (B)	1	2445.7	44.7**
	A x B	2	67.2	.2
	Residual	162	54.7	
CR	Treatments (A)	2	26.0	.8
	GS Levels (B)	1	924.0	29.8**
	A x B	2	29.2	.9
	Residual	162	31.0	
DR	Treatments (A)	2	39.0	3.2*
	GS Levels (B)	1	323.1	27.0**
	A x B	2	25.2	2.1
	Residual	162	12.0	

*$p < .05$
**$p < .001$

In terms of overall recall performance there was a significant main effect for GS levels. However, there was no main effect for treatments and no interactions.

Main effects for GS level were also significant for both CR and DR portions of the recall test. The only other significant difference involved a main effect for treatments for the DR portion of the recall test. However, an inspection of Table 6 reveals that means were consistently higher for T-A than for T treatments.

Application of a Dunnett post-hoc test to the DR recall data (in the same manner as was described for the analysis of the CR multiple-choice test) indicated that mean recall scores for the T-A treatment were significantly higher than for either the T treatment ($d = 2.4$, $p < .05$) or the T-U treatment ($d = 2.0$, $p < .05$).

Recall Versus Recognition

A relevant consideration is the degree of correspondence between the ability to recall and reconstruct content relationships, and the ability to select a correct response relative to those relationships. The results of a Pearson Product-Moment Correlation indicated a strong and statistically significant relationship between free-recall scores and multiple-choice test scores for the 168 subjects who received the instructional treatments ($r = .69$, $p < .001$).

Questionnaire Responses

Only the T-A group received organizational adjuncts. A comparison of the responses of T-A subjects with high and low GS scores was conducted to assess the usefulness of the adjunctive diagrams in helping them to organize, understand, and remember the text content. The subjects were asked to give a rating of "Very Useful," "Somewhat Useful, or "Not Useful." For helping them to organize and understand the content, a rating of "Very Useful" was given by 42 percent of the Highs and 39 percent of the Lows. A rating of "Somewhat Useful" was given by 57 percent of the Highs and 54 percent of the Lows. For facilitating retention, a rating of "Very Useful" was given by 42 percent of the Highs and 36 percent of the Lows. A rating of "Somewhat Useful" was given by 46 percent of the Highs and 42 percent of the Lows.

On a scale of 1 to 3 (where "Not Useful" was given a value of 1 and "Very Useful" a value of 3), mean ratings were compared for Highs and Lows. The results of this comparison indicated no difference between Highs and Lows for usefulness of the organizational aids in assisting them to organize and understand the content ($t = .39$, $p > .05$), or for helping them to retain the content ($t = .00$, $p > .05$). It appears that most of the subjects did find the aids useful and that Highs found them just as useful as did Lows.

For ease of understanding, subjects were instructed to rate the adjunctive diagrams as "Very Easy," "Relatively Easy," or "Difficult." Few subjects appeared to consider the diagrams "Difficult"; a rating of "Very Easy" was

given by 60 percent of the Highs and 32 percent of the Lows. A rating of "Relatively Easy" was given by 36 percent of the Highs and 50 percent of the Lows. On a scale of 1 to 3 (where "Difficult" was given a value of 1 and "Very Easy" a value of 3), a comparison of mean ratings indicated significantly higher ratings by the Highs ($t = 2.3$, $p < .05$), who apparently found the diagrams even easier to understand than did the Lows.

It had been hoped that the study periods would be sufficiently long to allow most subjects to study each topic area thoroughly. However, many subjects indicated that they did not have sufficient time to complete all of the topics. For Highs the mean number of topics covered was 2.96 for treatment T, 3.50 for T-U, and 2.96 for T-A. For Lows the mean number was 2.25 for treatment T, 2.59 for T-U, and 2.73 for T-A. The summary for a 2 x 3 ANOVA for these scores is presented in Table 8. The results indicate a main effect for GS level but no effect for treatments and no interactions. Therefore, although topic coverage was incomplete, it was consistent across treatment groups.

Table 8

ANOVA Summary for Levels of Course Completion for Treatment Groups

Source	df	ms	f
Treatments (A)	2	2.7	1.8
GS Levels (B)	1	12.6	8.3*
A x B	2	3.4	2.2
Residual	162	1.5	

*$p < .01$.

CONCLUSIONS

The primary purpose of this study was to evaluate an approach for improving learning by clarifying conceptual relationships contained in instructional texts. The approach involved an analysis of content to identify specified types of relationships and the graphic depiction of these relationships for use as adjunctive organizational aids.

The results of this study indicate that organizational aids can facilitate the learning of content relationships. Free-recall performance on a series of cause-and-effect relationships (DRs) and multiple-choice test performance on matrix-type relationships (CRs) were significantly enhanced. Even where significant gains were not achieved, mean scores were consistently higher for groups that received organizational aids with the text than for groups that received the text alone.

A secondary question was whether the effects of organizational aids could be attributed to their emphasis on certain items of information rather than to their organizational effects per se. Groups receiving the aids were compared with groups receiving text with the critical items underlined. For free-recall performance on cause-and-effect relationships (DRs), groups receiving the organizational aids were superior. However, for multiple-choice test performance on matrix-type relationships (CRs), organizational aids and underlined text passages were equally effective. These findings indicate that some part of the advantages gained from using organizational aids can be attributed to the emphasis that they place on certain portions of the content.

It has been hypothesized that the effects of the organizational adjuncts should be stronger for subjects with lower levels of previous learning achievement in similar content areas. Contrary to this expectation, no significant interaction between treatment and previous achievement level was indicated, although subjects with higher achievement levels consistently performed better on tests administered in the present study. Thus, it appears that organizational aids affect the performance of all personnel, not just those who experience learning difficulties.

There appeared to be a general correspondence between the recall of content relationships and the ability to answer questions about those relationships. The correlation between performance of free-recall and multiple-choice tests was significant. Such a relationship appears reasonable; student would not be expected to apply content that he could not recall.

For demonstrating the importance of organization for learning content relationships, the present findings are weak and inconsistent. The only condition where gains from organizational aids could be attributed to the effects of organization was the free recall of cause-and-effect relationships (DRs). Gains in multiple-choice performance on matrix-type relationships (CRs) could not be attributed to the organizational effects of the aids, since underlining statements within the text resulted in equally high performance levels. The fact that free recall was more sensitive to the effects of organization than performance on multiple-choice items is consistent with previous findings (Frase, 1969; Carter & Carrier, 1974).

To the extent that underlining relevant statements was as effective as organizing those statements into matrix diagrams, it might be hypothesized that the gains produced by the T-A and T-U treatments were simply a function of selective attention to the relevant content. However, selective attention to emphasized content might be expected to result in a deterioration of performance on other nonrelated content. No such deterioriation did, in fact, occur. A different explanation of the gains produced by underlining may be suggested that is more congruent with the position of Carter and Carrier (1974), who suggest that students have a robust ability to organize content subjectively. Identifying the critical points of information may have facilitated such subjective organization and subsequently allowed subjects to recognize relevant relationships by themselves.

The weak and inconsistent effects achieved in the present study parallel results from earlier efforts to establish superior performance advantages for one method of organization over another (Frase, 1969, 1973; Schultz & DiVesta, 1972; Myers et al., 1973; Friedman & Greitzer, 1972). Therefore, this study has substantiated earlier findings but with respect to more complex types of content relationships.

The continuing failure of efforts to demonstrate consistent advantages for particular organizational strategies raises, once again, the question of whether or not it is practical to systematize instructional organization. It may be that the benefits of specific content arrangements are so dependent upon the context of the instruction and the orientation of the individual student that no one method of depicting relationships is consistently superior. However, the potential advantages of adjunctive graphic displays cannot be completly dismissed. An important consideration that deserves additional attention is how the student perceives the instructional content. Although the content used in the present study was less artificial and closer to typical classroom instruction than that used in previous studies, the instructional situation was still presented to the subject in an experimental context. Subjects knew that their study times were to be brief and that the only application for the information would be on a subsequent test. Under such conditions their motivation may have been insufficient to produce differences in treatment group performance.

With an instructional content that is more useful to the student in terms of future needs, performance differences between treatment groups should increase. Since performance means on related content were consistently higher for subjects receiving texts supplemented with graphic displays than for subjects receiving texts alone, consistently significant advantages for the graphic aids might well result.

The effects of organizational aids may also be stronger where longer study and retention times are involved. In clarifying relationships, organizational aids provide a structure to help subjects to retain content. If the study periods are too short for the subjects to learn the relationships, however, and if the retention periods are not so long as to make it difficult for subjects to remember the content, then the benefits of organizational aids will be minimized. Two major orientations are suggested for future research into applications of organizational aids. First, the research should deal with instructional content that is relevant to the needs of the student. Second, the research design should allow for varying

the amount of time between the presentation of instructional content, the testing of recall, and the application of that content.

If organizational aids are shown to be effective under realistic conditions of instruction, they would provide a considerable advantage to the Navy's current effort to revise its course work development procedures. Over the next 12 years this effort will affect every major area of classroom instruction now being conducted by the Navy.

One of the key elements in the Navy's approach, as outlined in the Inter-service Procedures for Instructional Systems Development (1975), is the establishment of criterion levels of performance that the training materials must satisfy. If resulting course work is inadequate, then it must be revised until criterion levels are met. Systematic, rather than trial-and-error, techniques for organizing instruction must be used if requirements for such revisions are to be minimized with subsequent savings of time and money.

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APPENDIX

OPINION QUESTIONNAIRE

OPINION QUESTIONNAIRE

Please circle your response to the following questions:

1. The set of study materials you received covered four separate topics. How many of these were you able to study thoroughly in the study period?

   0 1 2 3 4

If you did not receive any review diagrams as part of your instruction go to Question 5. If you did receive review diagrams, answer Questions 2-4 before going on to Question 5.

2. How useful were the review diagrams in helping you to organize and understand the information you studied?

   Very Useful Somewhat Useful Not Useful

3. How useful were the review diagrams in helping you to remember the information you studied?

   Very Useful Somewhat Useful Not Useful

4. How easy were the diagrams to understand?

   Very Easy Relatively Easy Difficult

5. Do you have any suggestions for improving the effectiveness of the materials?